



# Researchers use light to create rare uranium molecule

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## ***Opening a new field of study to understand uranium nitrides as a promising alternative to traditional nuclear fuels***

LOS ALAMOS, New Mexico, July 12, 2010—For the first time ever, scientists have used light energy to create a rare molecular uranium nitride (U-N) complex containing a discrete terminal U-N unit, where the nitrogen atom is bonded only to the one uranium atom, versus prior work where the nitrogen atom has always been bonded to two or more uranium atoms.

Scientists used photolysis on a uranium azide—a molecule containing one uranium atom and three nitrogen atoms—exposing it to ultraviolet light and using the energy from a

photon to break off nitrogen gas, resulting in a molecule with a single uranium nitride group.

This breakthrough is important because uranium nitride materials show promise as advanced nuclear fuels due to their high density, high stability, and high thermal conductivity—enabling them to run cooler in advanced reactors.

The research appears in the current issue of *Nature Chemistry*, a monthly international scientific journal that reports the most significant and cutting-edge research in all areas of chemistry.

Uranium nitride is a ceramic compound that contains many repeating units of U-N. In contrast, the new uranium nitride molecule contains only one U-N, which is the smallest unit observed in the ceramic solid. The uranium nitride molecule derived from the photolysis process is well defined, unlike solid-state compounds from alternative processes, making it ideal for the controlled study of its physical and chemical properties, a longstanding challenge in uranium chemistry and materials science.

“Actinide nitrides are candidate nuclear fuels of the future, particularly in next-generation reactors developed to meet the energy needs of the 21st century, such as a small modular nuclear power reactors, and for future space missions,” said Jaqueline Kiplinger of Los Alamos National Laboratory’s Materials Physics & Applications Division.

“Now we’ve created a molecular model that can help us better understand the functional properties, electronic structure, and chemical reactivity of a single isolated uranium nitride unit, opening a new chapter in uranium chemistry.”

The rare molecule is reactive, able to attack strong carbon-hydrogen bonds to form new nitrogen-hydrogen and nitrogen-carbon bonds. This important discovery demonstrates that the molecular uranium nitride structure is not inert and can undergo reactions with strongly bonded molecules.

“Synthesis of a discrete terminal uranium-nitride functionality has been a holy grail for actinide chemists for the past several decades,” explained David Clark, director of the G.T. Seaborg Institute for Transactinium Science. “Its ultimate discovery is a testimony to the tenacity and skill of the research team, and its chemical and physical properties will teach us a great deal about the nature of chemical bonding in this unusual and fascinating molecular U-N bond.”

The research team includes Robert Thomson, a Seaborg Postdoctoral Fellow at Los Alamos, Brian Scott and David Morris (all of the Materials Physics & Applications Division) and Thibault Cantat and Enrique Batista (both of the Lab’s Theoretical Division). The research was supported by the DOE Office of Science-Heavy Element Chemistry program, the Los Alamos Laboratory Directed Research and Development program, and through Los Alamos National Laboratory Director’s and Seaborg Institute Postdoctoral Fellowships.

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